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A METHOD FOR REMOVAL OF HYDROCARBONS FROM GAS-VAPOR MIXTURES WHICH ARE FORMED DURING STORAGE OF OIL OR OIL PRODUCTS AND FILLING OF TANKS WITH OIL OR OIL PRODUCTS, INCLUDING AN EJECTOR PUMP INSTALLATION FOR METHOD REALIZATION

[SPOSOB OCHISTKI OT UGLEVODORODOV PAROGAZOVOY SMESI, OBRAZUYUSHCHEISYA PRI KHRANENII NEFTI ILI NEFTEPRODUKTA I PRI ZAPOLNENII IMI EMKOSTEY, I NASOSNO-EZHEKTORNAYA USTANOVKA DLYA EGO OSUSHCHESTVLENIYA]

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/3

This invention pertains to the field of fluidics, primarily to the methods with application of ejector pump installations in the systems designed for removal of hydrocarbons from gas-vapor mixtures of oil or oil products which are ejected into the atmosphere. There is a known method for storage and filling of evaporating products which includes pumping of liquid products into a tank followed by removal of product vapors from the tank (See Patent RU 2035365, Cl. B 65 D 90/30 of May 20, 1995).

The same patent covers an installation, which is composed of an oil product tank, a pump, a jet pump, and a separator placed in tandem.

This installation as well as the method of storage and filling secures the removal of vapors of liquid product from the tank; however, this method is rather sophisticated and it requires not only a system for condensation of vapors in a condenser accompanied by disposal of condensate

[1] Numbers in the margin indicate pagination in the foreign text.

into a special vessel but also the application of another system for removal of non-condensed vapors and gases (including atmospheric air) into a vessel from which the vaporizing product is filled into the tank.

As to its engineering principle and the result achieved, the most similar to our invention is a method for removal of hydrocarbons from gas-vapor mixtures of oil or oil products which are formed during storage of oil or oil products and filling of tanks with oil and oil products; this method includes pumping of liquid medium into a gas-liquid jet apparatus; pump out of gas-vapor mixture from a tank filled with oil or oil product using the apparatus; compression of the mixture in the gas-liquid jet apparatus at the cost of energy of forced liquid medium; feeding a mixture of gas-vapor mixture with liquid medium which was formed at mixing in the gas-liquid jet apparatus the into a separator; separation of the mixture in the separator into gaseous phase and liquid medium, and withdrawal of liquid medium from the separator to the pump inlet to form thereby a fluid flow circuit; in doing this liquid medium is partially discharged from the fluid flow circuit (See Patent SU 1512870 Cl. B 65 D 90/30 of October 07, 1989).

From the same Patent # 1512870 we know about an ejector pump installation which includes a pump, a gas-liquid jet apparatus, and a liquid phase discharge separator; according to this design, the gas-liquid jet apparatus is connected with its liquid medium inlet to the pump outlet, and with its gas-vapor mixture outlet to the source of this mixture (a tank filled with oil or oil product); further, the gas-liquid jet apparatus is connected with its outlet to a separator and the separator's liquid medium outlet to the pump inlet thus forming a fluid flow circuit: separator – pump – gas-liquid jet apparatus – separator.

This method and installation provide proper compression and condensation of hydrocarbon gases resulting from oil products. However, with this method it is impossible to secure an adequate reduction in the emissions of environmentally harmful hydrocarbon vapors which are contained in the gas-vapor mixtures formed in tanks during their filling with oil products below the levels of maximum emissions concentrations (MEC) for their release into the atmosphere; thus, the emissions of the named gas-vapor mixtures into the environment are illegal.

The purpose of our invention is to extend the functional capabilities of the ejector pump installation based on improvement of the efficiency of the method for removal of hydrocarbons from gas-vapor mixtures of oil or oil products which are formed during storage of oil or oil products and filling of tanks with oil and oil products; bring the concentrations of these vapors below the levels of maximum emissions concentrations (MEC) and also reduce evaporation losses of oil products.

We have solved the above problem based on the invented method for removal of hydrocarbons from gas-vapor mixtures of oil or oil products which are formed during storage of oil or oil products and filling of tanks with oil and oil products; this method includes pumping of liquid medium into a gas-liquid jet apparatus; pump out of gas-vapor mixture from a tank filled with oil or oil product using the apparatus; compression of the mixture in the gas-liquid jet apparatus at the cost of energy of forced liquid medium; feeding a mixture of gas-vapor mixture with liquid medium which was formed at mixing in the gas-liquid jet apparatus the into a separator; separation of the mixture in the separator into gaseous phase and liquid medium, and withdrawal of liquid medium from the separator to the pump

inlet to form thereby a fluid flow circuit; in doing this the liquid medium is getting partially discharged from the fluid flow circuit, and the gaseous phase from the separator passes into an column absorber; further, an hydrocarbon-containing liquid acting as an absorbent is fed into the absorber under a pressure lower than the value of pressure of saturated vapors or oil or an oil product, and in the column absorber is being realized the process of absorption of hydrocarbons from the gaseous phase by the hydrocarbon-containing liquid; thereafter the gaseous phase freed of hydrocarbons is removed from the column absorber, and hydrocarbon-containing liquid with dissolved hydrocarbons passes for mixing with liquid medium; then the liquid medium is getting partially discharged from the fluid flow circuit into the system of separation of absorbed hydrocarbons from liquid medium; in the latter system the gaseous hydrocarbon-containing phase is getting separated from liquid medium, and the hydrocarbon-containing liquid produced after the separation passes into the column absorber and further; it will be mixed with the liquid medium, thus reducing the relative contents of hydrocarbons absorbed from gas-vapor mixture in the liquid

medium fed into the gas-liquid jet apparatus and also improving the absorption properties of the medium.

/4

As the hydrocarbon-containing liquid for feeding the column absorber is suitable an oil fraction having the boiling range of 65 to 420 ˚C; the gas-vapor mixture is being compressed in a gas-liquid jet apparatus from 0.08 – 0.12 MPa to 0.15 – 0.7 MPa values of pressure; liquid medium is pumped into the gas-liquid jet apparatus under 1.1 – 10.0 MPa pressure. What is more, liquid medium which is contained in the system of separation of absorbed hydrocarbons from liquid medium passes into a rectification column, and gaseous hydrocarbon-containing medium after its separation from liquid medium in the rectification column could be directed into a condenser for the purpose of condensation of most of heavy hydrocarbons (those of propane and butane groups or heavier); further, a mixture of condensate with the non-condensed fraction of gaseous hydrocarbon-containing medium (which primarily contains the hydrocarbons of methane and ethane groups)passes into an auxiliary separator in which the non-condensed fraction of gaseous hydrocarbon-containing medium is getting separated from condensate; thereafter, the non-condensed fraction of

gaseous hydrocarbon-containing medium from the auxiliary separator passes to using equipment, and condensate from the auxiliary separator passes to condensate using equipment; in doing this, a share of condensate is used as a reflux in the rectification column.

As to the installation design as the object of invention, the solution of this problem is based on the application of an ejector pump installation which includes a pump, a gas-liquid jet apparatus, and a liquid phase discharge separator; according to this design, the gas-liquid jet apparatus is connected with its liquid medium inlet to the pump outlet, and with its gas-vapor mixture outlet to the source of this mixture (a tank filled with oil or oil product); further, the gas-liquid jet apparatus is connected with its mixture outlet to a separator and the separator's liquid medium outlet is connected to the pump inlet thus forming a fluid flow circuit: separator – pump – gas-liquid jet apparatus – separator; further, our installation is equipped with a column absorber and with a system for separation of absorbed hydrocarbons from liquid medium; according to our design the column absorber is connected to the outlet of gaseous phase from the separator; the upper section of the column absorber is

connected to a discharge pipeline for gaseous phase freed of hydrocarbons, and the system for separation of absorbed hydrocarbons from liquid medium includes a rectification column with a liquid medium feeding pipeline and hydrocarbon-containing liquid and a gaseous hydrocarbon-containing medium discharge pipeline; in doing this, the liquid medium feeding pipeline on its inlet side is connected to the fluid flow circuit over the section of liquid medium flow from the separator to the gas-liquid jet apparatus; the gaseous hydrocarbon-containing medium discharge pipeline is connected to the upper section of the column absorber.

As the rectification column could be used either a diesel fraction stabilization column or a rectification stripping tower; further, the system for separation of absorbed hydrocarbons from liquid medium may additionally include a condenser and an auxiliary separator fitted with non-condensed fraction of gaseous hydrocarbon-containing medium discharge pipeline and a condensate discharge pipeline; the latter pipeline is used for supply a share of condensate to using equipment whereas another share of condensate is being fed as reflux into the rectification column.

The gas-vapor mixtures to be withdrawn from storage tanks or oil product filling/drainage ramps during the operations of filling/drainage of different types of tanks contain air and also considerable concentrations of hydrocarbons. To illustrate, in the case of gasoline the concentrations of this oil product in gas-vapor mixtures may vary from 500 to 1,500 g/m^3 and higher. So, the high concentrations of hydrocarbons in gas-vapor mixtures at the points of their emission into the atmosphere will cause contamination of the environment and also losses of commercial-grade products, in the present case gasoline. Because of this, such gas-vapor mixtures prior to their discharge into the atmosphere should be freed of hydrocarbons; at the same time such operation will reduce losses of commercial-grade products.

Our invented method makes it possible to reduce the concentrations of hydrocarbons in the drawn away gas-vapor mixture to the levels below maximum emissions concentrations (MEC) for these vapors at their discharge into the environment. In doing this the liquid medium pumped into a gas-liquid jet apparatus could be concurrently used both for withdrawal of gas-vapor mixture from a tank during its filling with oil or oil product or

from an oil/oil product storage tank and for absorption of environmentally harmful hydrocarbons from the gas-vapor mixture pumped out. As the liquid medium could be used a hydrocarbon-containing liquid, specifically, heavy gasoline fraction, kerosene fraction, or diesel or gas oil fraction of oil refining which efficiently absorb hydrocarbons from the gas-vapor mixture. It is important that the hydrocarbon-containing liquid to be fed into the installation should have the value of saturated vapor pressure at the temperature of this liquid feeding lower than the value of saturated vapors of hydrocarbons in a gas-vapor mixture of oil or oil product. With a value of saturated vapor pressure of hydrocarbon-containing liquid lower as compared to that of saturated vapor pressure for oil or oil products, specifically, for hydrocarbons of gas-vapor mixture contained in the tank, it is possible to achieve efficient realization of the process of hydrocarbon absorption from gas-vapor mixture getting withdrawn. Moreover, we observe a considerable reduction in the intrinsic evaporation ratio for hydrocarbon-containing liquid in the course of absorption. It should be noted that the service efficiency of the installation which is based

on the invented method for removal of hydrocarbons could depend on the operating parameters of installation.

/5

It is advantageous to compress the gas-vapor mixture in gas-liquid jet apparatus from 0.08 - 0.12 MPa to 0.15 - 0.7 MPa values of pressure and pump the liquid medium into gas-liquid jet apparatus under 1.1 - 10.0 MPa pressure. The selected ranges of these parameters are based on the fact that pumping of liquid medium under a pressure lower than 1.1 MPa does not secure a required compression ratio for gas-vapor mixture in the jet apparatus and its required capacity thus making the invented method for removal of hydrocarbons uncompetitive. What is more, the operating conditions in the jet apparatus are not optimal for the realization of the process of hydrocarbon absorption. Characteristically, feeding of the liquid medium under a pressure higher than 10 MPa could result in a higher operating capacity of the jet apparatus; however, such an increase in the capacity does not compensate for a higher consumption of energy for the generation of liquid medium pressure; eventually, this will reduce the efficiency of the installation. Otherwise, the compression gas-vapor mixture in gas-liquid jet apparatus under a pressure higher

than 0.7 MPa will secure a high degree of removal of hydrocarbons from gas-vapor mixture; however, this will be accompanied by a significant increase in the power consumption of the installation which is required for realization of the invented method. It should be noted that the above ranges of the installation's operating parameters are interdependent, and the named values of liquid medium delivery pressure secure the attainment of the named parameters of gas-vapor mixture withdrawal and compression. The required service efficiency of the installation at minimal power consumption will be guaranteed within the above range of parameters.

The invented method provides for a multistage process of interaction between the pumped out hydrocarbon-containing gas-vapor mixture and a hydrocarbon-containing fluid, specifically, an oil fraction having the boiling range of 65 to 420 °C. The initial interaction of the liquid medium that contains hydrocarbon-containing fluid occurs in a gas-liquid jet apparatus which pumps the gas-vapor mixture out of a tank and compresses it. The process of absorption of hydrocarbons from gas-vapor mixture by liquid medium is getting started during this interaction. This process proceeds up to the instant of separation of

mixture in the separator into liquid medium and gaseous phase; this gaseous mixture actually, is a compressed gas-vapor mixture partially freed of hydrocarbons.

Further, the gaseous phase passes into a column absorber in which the process of reduction in the concentration of hydrocarbons in the gas-vapor mixture continues as a result of interaction with hydrocarbon-containing liquid fed into the absorber. The configuration of a counter-flow system for gaseous phase and hydrocarbon-containing liquid in the column absorber creates the conditions for the gaseous phase in which the concentrations of hydrocarbon vapors have been reduced due to its interaction with liquid medium in the jet apparatus to interact with a more clean hydrocarbon-containing liquid. Thus it is possible to reduce the concentrations of hydrocarbons in gases cleaned using the invented method as compared to their concentrations in the gas-vapor mixtures getting released from the tanks at their filling with oil or oil product. Based on feeding of hydrocarbon-containing liquid having a value of saturated vapor pressure lower than that of saturated vapor pressure for hydrocarbons into the column absorber, which is followed by mixing of this liquid with liquid medium it is possible also to launch a

concurrent process of replacement of the liquid medium fed into the jet apparatus: during its operation the liquid medium accumulates hydrocarbon condensate and this medium should be partially withdrawn from the installation.

As was noted above, during compression of the gas-vapor mixture it is possible to absorb environmentally harmful hydrocarbons. Based on proper selection of working liquid medium as well as simultaneous creation of conditions for dissolution of a share of gaseous-state hydrocarbons contained in the liquid medium that are optimal for absorption it is possible to realize the separation of gas-vapor mixture by composition even in the flow-through section of the jet apparatus; in so doing a lighter component, e.g. hydrocarbons of methane or ethane type remains in their compresses gaseous state, and heavier hydrocarbons like propane, butane and heavy hydrocarbons will be absorbed by liquid medium. It is significant that based on the process of intake or in other words the process of absorption, i.e. dissolution of gases in liquid medium it is possible to reduce the consumption of energy required for compression of the hydrocarbon-containing gas-vapor mixture. The way to do this is through the participation of two independent processes in the

compression and transportation of gas-vapor mixture into the separator; these processes include mechanical compression resulting from the kinetic energy of liquid medium jet and dissolution of gas in liquid medium; characteristically, the latter process is getting intensified as the pressure increases in the flow-through section of the jet apparatus and also in the pipeline after the flow-through section of the jet apparatus. Based on withdrawal of a share of liquid medium from the fluid flow circuit as well as realization of the process of desorption it is possible combine the process of separation of absorbed medium with that of stabilization of composition of liquid medium as a sorbent of hydrocarbon vapors; the liquid medium is fed into a nozzle of gas-liquid jet apparatus for the purpose of securing stable operation of the jet apparatus and simultaneous maintaining the absorbing capacity of liquid medium. Based on experiments it was found that with application of an oil fraction, specifically an oil fraction having the boiling range of 65 to 420 °C it is possible to solve the problem as per the invention. At the same time, depending on the requirements

/6

of using equipment or service conditions it is possible to supply the using equipment with gaseous hydrocarbon-containing medium which was separated in the process of desorption both in the liquid and gas states. Depending on the above as the primary components of the system for separation of absorbed hydrocarbons of the gas-vapor mixture from liquid medium could be used several different types of rectification columns, e.g. stabilization column for the said oil fraction, e.g. a diesel fraction or a rectification stripping tower. With application of a rectification column the liquid medium is getting heated, e.g. by the heat from stillage residue of rectification column (hydrocarbon-containing liquid) and it enters the rectification column. As a result of interaction with vapors of the stillage residue the vapors coming from the lower section of the rectification column from the liquid medium are evaporated light hydrocarbons which have been absorbed by the medium. During their ascent towards the top of the rectification column the vapors enter into a counter flow interaction with the reflux (condensate of gaseous hydrocarbon-containing medium); this process results in the enrichment of vapor with light hydrocarbons as well as the extraction of relatively heavier hydrocarbons from the

vapor. As a result the liquid medium in rectification column is getting separated into stillage residue, i.e. hydrocarbon-containing liquid to be withdrawn from the bottom of rectification column and distillate, i.e. gaseous hydrocarbon-containing medium to be withdrawn from the top of the column. In doing this the elements of this separation system will secure the required compositions and pressure values for the hydrocarbon-containing liquid and gaseous hydrocarbon-containing medium at the outlet from the separation system, and also a maximally possible separation of absorbed medium from liquid medium. Thus we have managed to achieve a balanced operation of the gas-liquid jet apparatus and our system for separation of absorbed hydrocarbons from liquid medium. Further, now it is possible to separate the liquid hydrocarbons (composed of relatively heavy hydrocarbons) from the gaseous hydrocarbon-containing medium obtained at the outlet from the rectification column through subsequent cooling and separation. The liquid hydrocarbons and gaseous hydrocarbon-containing medium (composed of relatively light hydrocarbons) resulting from the separation are supplied to the using equipment; besides, a share of liquid hydrocarbons could be passed into the rectification column

as reflux. As a result we managed to solve the problem as per the invention: to extend the functional capabilities of the installation and reach a considerable reduction in the concentrations of hydrocarbons in gas-vapor mixtures; on this basis it is possible to release purified gases from column absorbers into the natural environment without any environmental damage.

Our Figure illustrates a schematic diagram of the installation to realize the invented method for removal of hydrocarbons from gas-vapor mixtures of oil or oil products which are formed during storage of oil or oil products and filling of tanks with oil and oil products.

The installation includes a pump (2), a gas-liquid jet apparatus (3), a separator (1), and a column absorber (25). The gas-liquid jet apparatus (3) is connected with its liquid medium inlet to the outlet of pump (2), and also with its gas-vapor mixture outlet through a pipeline to a source of this mixture, e.g. a storage tank (24) for oil or oil product or a cistern to be filled with oil or an oil product (diesel fraction, gasoline or kerosene) through pipeline (23); further, the gas-liquid jet apparatus (3) is connected to its mixture outlet to a separator (1), and the separator’s (1) liquid medium outlet to the inlet of pump

(2). As a result we have formed a fluid flow circuit, i.e. continuous flow of liquid medium from pump (2) to gas-liquid jet apparatus (3), then to the separator (1) and further, toward the inlet of pump (2).

A column absorber (25) on its gaseous phase inlet side is connected to the outlet of gaseous phase from the separator (1). The column absorber (25) could be arranged above the level of liquid medium in the separator (1) and be positioned with its lower section on the separator (1); The upper section of the column absorber (25) is connected to a discharge pipeline (12), e.g. for release of the gaseous phase freed of hydrocarbons into the environment and also to a pipeline (7) for conveyance of hydrocarbon-containing liquid. According to a possible design modification of the installation the column absorber (25) is its lower section is connected to the separator (1) through a pipeline (nor shown on the schematic diagram). In compliance with this version of configuration of the installation the hydrocarbon-containing liquid with its dissolved hydrocarbons could be discharged from the column absorber (25) not only into the separator (2) but also into another points of the fluid flow circuit, e.g. to the pump

(2) from the side of its inlet for liquid medium from the separator (1).

The installation could be equipped with a heat exchanger/condenser (10) for stabilization of temperature of liquid medium in the installation. Withdrawal of a share of liquid medium from the fluid flow circuit is realized through pipeline (6).

The separator (1) is equipped with a pipeline (11) for feeding the installation with hydrocarbon-containing liquid or for replenishment of the installation with the said medium. A rectification column (5) is the primary component of the system (4) for separation of absorbed hydrocarbons from liquid medium. The rectification column (5) is equipped with a circulating pump (15) and an appliance (16), e.g. a furnace of a heat exchanger for heating of stillage residue in the rectification column (5).

/7

In case of necessity to withdraw a share of gaseous hydrocarbon-containing medium as liquid phase (generally, a light gasoline fraction) the system (4) for separation of absorbed hydrocarbons from liquid medium may additionally include a condenser (17) and an auxiliary separator (9) fitted with a pipeline (20) for withdrawal of non-condensed

fraction of the gaseous hydrocarbon-containing medium and also with a pipeline (27) for withdrawal of its condensate; the pipeline (27) is connected to a pump (18) for supply of the condensate (liquid hydrocarbons) to using equipment; in doing this are share of condensate id getting fed through pipeline (19) as reflux into the rectification column (5).

The rectification column (5) could be fitted with pipelines (13, 14) which are required for conveyance of a hydrocarbon-containing medium, e.g. diesel fraction, for stabilization.

Further, on the pipeline (7) could be mounted a heat exchanger (22) for heating of the liquid medium which enters the rectification column (5) by heat from hydrocarbon-containing liquid which is discharged from the rectification column (5). What is more, on the pipeline (7) could be mounted a heat exchanger/condenser (26) for the purpose of additional cooling of the hydrocarbon-containing liquid prior to its feeding into the upper section of column absorber (25).

The method for removal of hydrocarbons from gas-vapor mixtures of oil or oil products which are formed during storage of oil or oil products and filling of tanks with oil and oil products is realized as follows.

Liquid medium from the separator (2) is pumped with a pump (2) under a 1.1 to 10.0 MPa pressure into a nozzle of gas-liquid jet apparatus (3). When flowing out of the nozzle, a jet of liquid medium will pump out gas-vapor mixture from a tank (21) during its filling with oil or oil product or from a storage tank (24) for oil or oil product. This gas-vapor mixture is a mixture of vapors, hydrocarbons, and gases, including atmospheric air. In the gas-liquid jet apparatus (3) during the process of mixing of liquid medium with the gas-vapor mixture will take place transfer of a share of kinetic energy from the jet of liquid phase of gas-vapor mixture; this is accompanied by formation of two-phase mixture in the jet apparatus (3). Concurrently, during the process of its mixing with gas-vapor mixture, the liquid phase will absorb a share of hydrocarbons contained in the gas-vapor mixture. As a result of retardation within the flow-through section of jet apparatus (3) the kinetic energy of a flux of the mixture will be partially converted into the potential energy of pressure, thus resulting in compression of the gas-vapor mixture from a pressure of 0.08 - 0.12 MPa to AZ pressure of 0.15 - 0.7 MPa. Besides the absorption of hydrocarbons by liquid medium within the flow-through

section of jet apparatus (3), there is also a possibility for condensation of a share of hydrocarbons. The processes of absorption and condensation of hydrocarbons may continue in the pipeline after the jet apparatus (3) and in the separator (1). Further, in the separator (1) occurs separation of mixture into the liquid medium and gaseous phase; the latter actually is a compressed gas-vapor phase with reduced concentrations of hydrocarbons. Thereafter, liquid medium from the separator (1) arrives to the inlet of pump (2), and gaseous phase from the separator (1) is getting fed into the lower section of column absorber (25); in parallel, into the upper section of column absorber (25) is being fed with a hydrocarbon-containing liquid (oil fraction) under a pressure lower than the value of pressure of saturated vapors or oil or oil product, e.g. a heavy gasoline fraction, kerosene fraction, or diesel or gas oil fraction of oil refining. As a result of the interaction between the fluxes of gaseous phase and hydrocarbon-containing liquid the liquid absorbs hydrocarbons from the gaseous phase thus reducing their concentration below the levels of maximum emissions concentrations (MEC) for hydrocarbon release into the atmosphere. The gaseous phase freed of hydrocarbons is released through pipeline (12)

from the upper section of the column absorber (25), e.g. into the environment; concurrently, from the lower section of the column absorber (25) the hydrocarbon-containing liquid with dissolved hydrocarbons is getting released into a fluid flow circuit (e.g. into separator (1)); the circuit realizes a continuous flow of liquid from pump (2) to the gas-liquid jet apparatus (3), then to the separator (1) and further, toward the inlet of pump (2). Thus through feeding of the hydrocarbon-containing liquid we are solving two problems at a time, i.e. we minimize the concentrations of hydrocarbons in the gaseous phase to be released beyond the limits of the installation and also replenish our liquid medium with the hydrocarbon-containing liquid to maintain the required physical and chemical composition of the liquid medium in its fluid flow circuit.

From the fluid flow circuit a share of liquid medium is directed towards the system (4) for separation of absorbed hydrocarbons contained in the gas-vapor medium from liquid medium; the primary component of this system is a rectification column (5). Prior to entering the rectification column (5) the liquid medium is getting heated in a heat exchanger (22) at the expense of cooling of hydrocarbon-containing liquid withdrawn from

rectification column (5). As a result of the interaction with vapors of stillage residue ascending in the rectification column (5) from its lower section from the liquid medium will be evaporated its absorbed light hydrocarbons. During the process of upward movement within the rectification column (5) the vapors will interact with reflux (condensate of gaseous hydrocarbon-containing medium) during their counter flow; the latter results in enrichment of vapors with light hydrocarbons as well as removal of relatively heavier hydrocarbons from these vapors. As a result the liquid medium in rectification column (5) is getting separated into stillage residue, i.e. hydrocarbon-containing liquid and distillate, i.e. gaseous hydrocarbon-containing medium. In doing this the elements of the separation system (4) will secure the required compositions and pressure values for the hydrocarbon-containing liquid and gaseous hydrocarbon-containing medium at the outlet from the system, and also a maximally possible separation of absorbed medium from liquid medium.

/8

The released gaseous hydrocarbon-containing medium from rectification column (5) through pipeline (8) is supplied to the using equipment, and the hydrocarbon-containing

liquid formed after the separation of gaseous medium (residue from the rectification column (5)) is being pumped using the circulation pump (15) into the fluid flow circuit thus reducing the relative concentration of absorbed hydrocarbons in the liquid phase and forming thereby a liquid medium which is fed into the gas-liquid jet apparatus (3) and will act a sorbent for the gas-vapor mixture. Further, a share of stillage residue is being pumped with circulating pump (15) into a heating appliance (16) and further, into the rectification column (5) for the purpose of heating of still of the column (5); characteristically, in the rectification column (5) for stabilization of diesel fraction as the heating appliance (16) usually is used a furnace whereas the application of rectification stripping towers most often is based on heat exchangers. As was noted above, liquid medium is getting heated in the heat exchanger (22). It is important that this method also provides us with the opportunities for simultaneous cooling of the hydrocarbon-containing liquid directed towards the fluid flow circuit as a result of exchange of heat between the said liquids. In cases where cooling of the hydrocarbon-containing liquid in the heat exchanger (22) is insufficient, on the pipeline (7) could

be installed an additional heat exchanger/condenser (26) for the purpose to provide additional cooling of the hydrocarbon-containing liquid prior to its feeding into the upper section of the column absorber (25).

Further, depending on the conditions and requirements for using equipment it is also possible to remove a share of gaseous hydrocarbon-containing medium from the system (4) in its liquid phase. In this case the hydrocarbon-containing medium released from the rectification column (5) is directed through a discharge pipeline (8) and condenser (17) towards an auxiliary separator (9) in which are getting condensed most of the "heavy" hydrocarbons of propane and butane groups and heavier; concurrently, a share of light gaseous hydrocarbons, primarily those of methane and ethane groups are directed as a compressed hydrocarbon-containing medium from the auxiliary separator (9) through pipeline (20) to the using equipment. As to the condensate, from the auxiliary separator (9) through pipeline (27) it is pumped to the using equipment; characteristically, a share of condensate is getting fed as reflux into the rectification column (5) through pipeline (19).

Using a pipeline (13 or 14) it is also possible to feed the hydrocarbon-containing liquids from other sources into the rectification column (5) for stabilization. For this purpose most often is being used a diesel fraction, which is applied in the rectification columns of diesel fraction stabilization. At the same time, using this method we could solve the problem of hydrocarbon-containing liquid replenishment in the fluid flow circuit; this will contribute into the stable operation of jet apparatus (3) and also enhance the absorption capacity of the hydrocarbon-containing liquid.

The invented method for removal of hydrocarbons from gas-vapor mixtures of oil or oil products which are formed during storage of oil or oil products and filling of tanks with oil and oil products and also the installation for its realization are suitable for application in the chemical, petrochemical, and other industries.

THE CLAIMS

1. A method for removal of hydrocarbons from gas-vapor mixtures of oil or oil products which are formed during storage of oil or oil products and filling of tanks with oil and oil products; the method which includes pumping of liquid medium into a gas-liquid jet apparatus; pump out of

gas-vapor mixture from a tank filled with oil or oil product using the apparatus; compression of the mixture in the gas-liquid jet apparatus at the cost of energy of forced liquid medium; feeding a mixture of gas-vapor mixture with liquid medium which was formed at mixing in the gas-liquid jet apparatus the into a separator; separation of the mixture in the separator into gaseous phase and liquid medium, and withdrawal of liquid medium from the separator to the pump inlet to form thereby a fluid flow circuit; in doing this the liquid medium is getting partially discharged from the fluid flow circuit; the method distinctive in that the gaseous phase from the separator passes into an column absorber; further, an hydrocarbon-containing liquid acting as an absorbent is fed into the absorber under a pressure lower than the value of pressure of saturated vapors or oil or an oil product, and in the column absorber is realized the process of absorption of hydrocarbons from the gaseous phase by the hydrocarbon-containing liquid; thereafter the gaseous phase freed of hydrocarbons is removed from the column absorber, and hydrocarbon-containing liquid with dissolved hydrocarbons passes for mixing with liquid medium; then the liquid medium is getting partially discharged from the

fluid flow circuit into the system of separation of absorbed hydrocarbons from liquid medium; in the latter system the gaseous hydrocarbon-containing phase is getting separated from liquid medium, and the hydrocarbon-containing liquid produced after the separation passes into the column absorber and further; it will be mixed with the liquid medium, thus reducing the relative contents of hydrocarbons absorbed from gas-vapor mixture in the liquid medium fed into the gas-liquid jet apparatus and also improving the absorption properties of the medium.

2. The method as per Claim 1 above which is distinctive in that as the column absorber is being fed with an oil fraction having the boiling range of 65 to
420 ˚C

3. The method as per Claim 1 above which is distinctive in that the gas-vapor mixture in the gas-liquid jet apparatus is being compressed from 0.08 - 0.12 MPa to 0.15 - 0.7 MPa values of pressure, and the liquid medium is pumped into this gas-liquid jet apparatus under 1.1 - 10.0 MPa pressure.

/9

4. The method as per Claim 1 above which is distinctive in that the liquid medium in the system for

separation of absorbed hydrocarbons from liquid medium is directed into a rectification column.

5. The method as per Claim 4 above which is distinctive in that the gaseous hydrocarbon-containing medium after its separation from liquid medium in the rectification column is directed into a condenser for the purpose of condensation of most of heavy hydrocarbons (those of propane and butane groups or heavier); further, a mixture of condensate with the non-condensed fraction of gaseous hydrocarbon-containing medium (which primarily contains the hydrocarbons of methane and ethane groups) passes into an auxiliary separator in which the non-condensed fraction of gaseous hydrocarbon-containing medium is getting separated from condensate; thereafter, the non-condensed fraction of gaseous hydrocarbon-containing medium from the auxiliary separator passes to using equipment, and condensate from the auxiliary separator passes to condensate using equipment; in doing this, a share of condensate is used as a reflux in the rectification column.

6. An ejector pump installation which includes a pump, a gas-liquid jet apparatus, and a liquid phase discharge separator; according to this design, the gas-liquid jet apparatus is connected with its liquid medium inlet to the

pump outlet, and with its gas-vapor mixture outlet to the source of this mixture (a tank filled with oil or oil product); further, the gas-liquid jet apparatus is connected with its mixture outlet to a separator and the separator’s liquid medium outlet is connected to the pump inlet thus forming a fluid flow circuit: separator – pump – gas-liquid jet apparatus – separator; further, our installation is equipped with a column absorber and with a system for separation of absorbed hydrocarbons from liquid medium; according to our design the column absorber is connected to the outlet of gaseous phase from the separator; the upper section of the column absorber is connected to a discharge pipeline for gaseous phase freed of hydrocarbons, and the system for separation of absorbed hydrocarbons from liquid medium includes a rectification column with a liquid medium feeding pipeline and hydrocarbon-containing liquid and a gaseous hydrocarbon-containing medium discharge pipeline; in doing this, the liquid medium feeding pipeline on its inlet side is connected to the fluid flow circuit over the section of liquid medium flow from the separator to the gas-liquid jet apparatus; the gaseous hydrocarbon-containing medium

discharge pipeline is connected to the upper section of the column absorber.

7. The installation as per Claim 6 above which is distinctive in that as the rectification column have been applied a rectification column for stabilization of diesel fraction.

8. The installation as per Claim 6 above which is distinctive in that as the rectification column have been applied a rectification stripping tower.

9. The installation as per Claim 6 above which is distinctive in that the system for separation of absorbed hydrocarbons from liquid medium additionally includes a condenser and an auxiliary separator fitted with non-condensed fraction of gaseous hydrocarbon-containing medium discharge pipeline and a condensate discharge pipeline; the latter pipeline is used for supply a share of condensate to using equipment whereas another share of condensate is being fed as reflux into the rectification column.

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